L&D HWG Fast Track Report for Continuous Turbulence NPRM & AC for 25.341
10 March 2000

ARAC WG Report Format

1 - What is the underlying safety issue to be addressed by the FAR/JAR?

To provide adequate strength for atmospheric turbulence encounters in service.

(a) The continuous turbulence requirements of 25.341(b) need to be revised to be consistent with the more current database and flight profile alleviation factor used for the 25.342(a) discrete gust requirements. Also remove the mission analysis criteria so as to provide a single consistent design requirement. There is a need to provide criteria for application to advanced flight controls with significant non-linearities.

(b) Due to events that have occurred in service, the NTSB (A-93-137), per Reference 1, has recommended changes in the turbulence/gust requirements for wing mounted engines. Reference 2 provides a record of the NTSB recommendations to the FAA and the FAA responses.

(c) The discrete gust requirements of 25.341(a) currently address altitudes up to 50,000 feet. Transport aircraft are being certified for altitudes above 50,000 feet, but less than 60,000 Feet. Therefore criteria are required for altitudes up to 60,000 feet.

The current requirements are in the opinion of the L&D HWG not unsafe. However it is felt that changes should be made to provide enhanced safety for future certification efforts.

2 - What are the current FAR and JAR standards relative to this subject?

Current FAR text:

25.341(b) The dynamic response of the airplane to vertical and lateral continuous turbulence must be taken into account. The continuous gust design criteria of appendix G of this part must be used to establish the dynamic response unless more rational criteria are shown.

(Appendix G offers a range of design requirements ranging from design envelope to mission analysis. In addition, the design envelope gust requirements may be reduced where the administrator finds that a design is comparable to a similar design with satisfactory service history.)

25.341(a)(5) ..... the reference gust velocity may be further reduced linearly from 44.0 fps EAS at 15,000 feet to 26.0 fps EAS at 50,000 feet.

Current JAR text:

25.341(b) The dynamic response of the airplane to vertical and lateral continuous turbulence must be taken into account. [See ACJ 25.341(b)]
(The ACJ offers the same range of design requirements, as does Appendix G.)

25.341(a)(5) (1) ..... the reference gust velocity may be further reduced linearly from 44.0 fps EAS at 15,000 feet to 26.0 fps EAS at 50,000 feet.

2a – If no FAR or JAR standard exists, what means have been used to ensure this safety issue is addressed?

The existing standards are being applied. The changes are intended to enhance the level of safety in particular by addressing special requirements for wing mounted engines

3 - What are the differences in the FAA and JAA standards or policy and what do these differences result in?:

Rule text and interpretation are essentially the same. Appendix G of the FAR and the interpretative materials in ACJ 25.341(b) are also essentially the same.

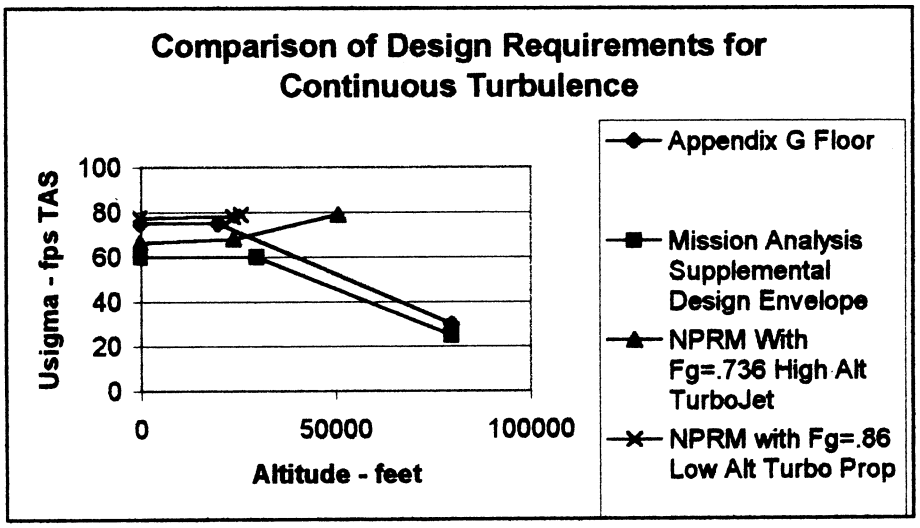
4 - What, if any, are the differences in the current means of compliance?

None.

5 – What is the proposed action?

Develop a new JAR and FAR continuous gust paragraph 25.341(b) that prescribes the new gust intensities, eliminates the mission analysis approach, sets forth a new standard for multi-axis gusts for wing mounted nacelles in accordance with the NTSB A-93-137 recommendation, and provides criteria for application to advanced flight controls with significant non-linearities. All of the requirements would be contained within the paragraph 25.341(b) and the existing Appendix G (FAR) and the current ACJ 25.341(b) would be cancelled.

The following chart compares the Usigma turbulence intensities for Appendix G and the NPRM. There is another maximum requirement in Appendix G that starts at 85 fps at altitudes up to 30,000 feet and then decreases linearly to 30 fps at 80,000 feet. However that requirement was rarely used due to the lower available options as shown in the chart.



Revise JAR and FAR 25.341(a) to extend the discrete gust velocities to an altitude of 60,000 feet.

Revise the FAR 25.1517 Vra speed to be consistent with the changes in design airspeeds brought about by the changes in the gust intensities in 25.341.

For each proposed change from the existing standard, answer the following questions:

6 - What should the harmonized standard be?

Move the Appendix G criteria to main rule text in 25.341(b). Revise Usigma turbulence levels, add a flight profile alleviation factor, and eliminate the mission analysis option. Add criteria for non-linear control systems.

Refer to the NPRM text for 25.341(b). The revised turbulence levels are based upon data as discussed in References 3 and 4.

Add multiaxis gust criteria for wing mounted engines

Refer to the NPRM text for 25.341(c). The criteria for phased vertical and lateral gust for wing mounted engines are based upon Reference 5. The criteria meet the intent of the NTSB A-93-137 recommendation.

Add considerations that are necessary for advanced flight controls

Refer to the NPRM text for 25.341(b)(4) and (5). The use of 40% of the U_σ values is selected in 25.341(b)(5) in order to minimize the amount of simulation time while achieving the same results.

Revise the gust intensities of 25.341(a)(5) to include altitudes up to 60,000 feet

Refer to the NPRM text of 25.341(a)(5). The only change is a linear extension of the gust velocity to 60,000 feet as opposed to the current maximum altitude of 50,000 feet.

Revise 25.1517 Vra to be consistent with the changes in design airspeeds brought about by the changes in gust intensities in 25.341

See the NPRM text for 25.1517. The change to Vra is based upon References 6 through 8.

Change 25.371, 25.373, AND 25.391 to properly reference the revised 25.341(a) and (b) paragraphs

See the NPRM text for these paragraphs.

7 - How does this proposed standard address the underlying safety issue (identified under #1)?

- Provides turbulence intensities and flight profile alleviation factor criteria that are compatible with the measured gust intensities and flight profile alleviation factor criteria that are currently in 25.341(a). The mission profile option is eliminated.
- Addresses the advanced flight control systems with significant non-linearities.
- Sets forth a multi-axis gust requirement for wing mounted nacelles to satisfy the NTSB A-93-137 recommendation.
- Extends the discrete gust velocities to 60,000 feet to cover the maximum altitudes at which transport aircraft are currently being certified.

The current turbulence velocities in Appendix G are not compatible with the database from which the current discrete gust velocities of 25.341(a) are derived. Also, there is agreement within the L&D HWG that one of the alternatives (mission analysis) for addressing continuous turbulence should be deleted in order to provide a singular design requirement. The rationale is that mission analysis is very sensitive to many assumptions made at the time the aircraft is designed. In-service usage of the aircraft may vary from the design assumptions.

There have also been difficulties in interpreting the gust requirements as they apply to advanced flight controls with significant non-linearities. Criteria and advisory material are now provided by the draft NPRM and AC.

In addition, the current requirement does not require the consideration of multi-axis phased gusts as recommended in NTSB Recommendation A-93-137. Such criteria are provided by the draft NPRM and AC.

The current 25.341(a)(5) only addresses gust velocities for altitudes up to 50,000 feet. Since there are aircraft being certified above that altitude, gust velocities have been provided for altitudes up to 60,000 feet.

8 - Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

The analytical methodology is improved and requires a full dynamic response analysis of the airplane, including multi-axis dynamic response of wing mounted nacelles.

In addition, the mission analysis method would be eliminated since it could allow a reduction in strength under certain mission assumptions.

The level of safety is enhanced by

- Defining requirements for more comprehensive dynamic analysis using a better representation of the atmospheric turbulence
- Providing criteria for non-linear automatic control systems
- Defining muti-axis phased gust requirements for wing mounted engines
- Extending the discrete gust requirements to an altitude of 60,000 feet

9 - Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain.

Increased because of the measures described in 8.

10 - What other options have been considered and why were they not selected?:

The only alternatives considered for the revision to the gust intensities were to either retain the existing ones or adopt the more recent measurements. The new intensities were deemed to more accurately represent the actual atmosphere. Also, manufacturers trial analyses did not result in excessive design penalties.

Several alternative proposals were considered in order to satisfy the NTSB A-93-137 recommendation. A multiaxis phased discrete gust approach, a round-the-clock gust criterion, an uncorrelated combined power spectral density method, and ignoring it all together. The round-the-clock approach alone was not considered to be a true multiaxial gust and for some configurations would not necessarily provide adequate loads. The uncorrelated and combined power spectral density method was deemed to be unrealistically conservative and too costly and the proposal to ignore the recommendation did not obtain group consensus. The final method is a simplified multiaxial discrete gust method backed up with a supplementary round-the-clock gust criterion.

11 - Who would be affected by the proposed change

Airplane manufacturers will be most affected.

12 - To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble?

See the rule text and advisory material as attached.

13 - Is existing FAA advisory material adequate? If not, what advisory material should be adopted?

Existing advisory material is not adequate.
A new advisory circular AC 25.341-1 is proposed. (See attachment)

14 - How does the proposed standard compare to the current ICAO standard?

The proposal is more detailed and comprehensive but enveloped by the general ICAO gust requirement in Annex 8, Part III, par. 3.3.2. "*Gust loads shall be computed for vertical and horizontal gust velocities and gradients which statistics or other evidence indicate will be adequate for the anticipated operating conditions.*"

15 - Does the proposed standard affect other HWG's?

No.

16 - What is the cost impact of complying with the proposed standard?

For a new design the costs should be minimal. To apply the criteria to an existing or derivative model could result in significant costs.

17. - If advisory or interpretive material is to be submitted, document the advisory or interpretive guidelines. If disagreement exists, document the disagreement.

Advisory Circular 25.341-1 is submitted and is attached. The AC provides not only guidance for the continuous gust requirement of this proposal, but also provides guidance for the discrete dynamic gust requirement previously published in amendment 25-86. There is no disagreement.

18.- -Does the HWG wish to answer any supplementary questions specific to this project?

No

19. – Does the HWG want to review the draft NPRM at "Phase 4" prior to publication in the Federal Register?

Yes

20. – In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process? Explain.

This issue is too complex for the Fast Track Process. The concepts are difficult and the issues are complex and are likely to generate public comment. The working group will need to continue to provide input for the cost/benefit analysis and will likely need to be tasked to address comments.

References

1. NTSB Letter to David Hinson. Dated 15 November 1993.
2. NTSB Recommendations to FAA amd FAA Responses Report. Dated 17 April 1998.
3. Letter report titled: Derivation of Continuous Turbulence Design Intensities From Operational Data. Dated November 1996. Authored by Vic Card.
4. FAA Tech Center Report DOT/FAA/CT-94/21 Reanalysis of European Flight Loads Data. Dated May 1994
5. Report DOT/FAA/AR-99/62, Titled: Studies Of Time-Phased Vertical and Lateral Gusts: Development of Multiaxis One-Minus-Cosine Gust Model. Dated: October 1999, Final Report.
6. Letter from V. Card to Miss J.L. Denning, Chairman of JAA Flight Study Group. Subject: Harmonisation of Rough Air Speed Requirements, dated: 11 August 1997.
7. Letter from G. D, Weightman, Chairman of JAA Flight Study Group to V. Card, subject: Harmonisation of Rough Airspeed Requirements, dated: 26 May 1998.
8. Document FWP 581by F. Iannarelli and C. Clerc, subject: Harmonisation of Rough Airspeed Requirements, dated: 30 Jan 1998.